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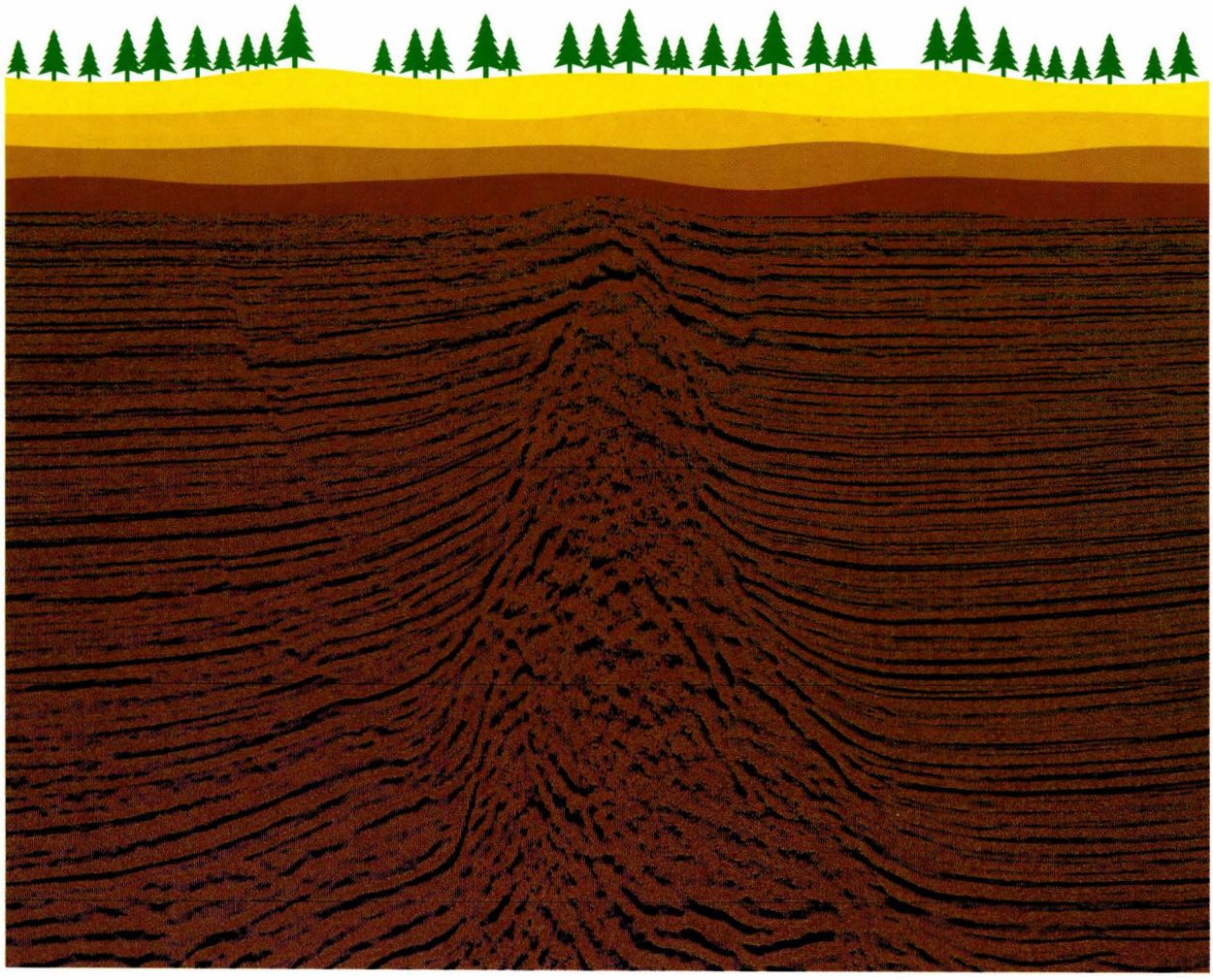
Geophysical Operations

Providing Needed Information on the Geology of the National Forest System



United States Department of Agriculture • Forest Service • International Association of Geophysical Contractors
FS-589 • October 1996

Cover: *Seismic record shown beneath illustration of land surface. Seismic record shows a subsurface structure, in this case a salt dome. Note there is no relation of subsurface structure and surface features, which is why seismic data is needed. Seismic record provided by Western Atlas.*

Contents

Letter From the Chief of the Forest Service **2**

Introduction and Purpose 2
The Importance of Energy and Mineral Resources 2
The Role of Geophysical Exploration 2
Some Agency Values 2

Unlocking the Secrets of the Earth **3**

The Importance of Subsurface Information 3
Geophysical Industry Objectives 3

Looking Into the Earth Beneath the Forest **3**

What Do We See? 3
The Stages of a Seismic Operation 6
The Tools Used 8

Protecting Proprietary Material **10**

More About the Forest Service **11**

Mission and Policy Statements 11
Organization 12

The Permitting Process in Action **12**

Private Initiative — Application Letter 12
Forest Service Response 12
Legal Framework 12

Appendixes **16**

Sample Application Letter and Permit 16
Recommended Resource Protection Offsets 18

A Letter from the Chief

Allow me to share some thoughts about geophysical exploration, which provides geologic information for managing America's national forests and grasslands.

These ecosystems and natural resources are among the Nation's greatest assets, having economic, environmental, and social significance for all Americans. They are managed for a variety of purposes, including watershed health, habitat for wildlife and plants, timber production, recreational use, grazing for range animals, and mineral extraction.

Energy and mineral resources provide a foundation for America's industrial base and are important to its economic and national security. Although imports can satisfy part of the needs for minerals and energy, with heavy dependence on these imports we become vulnerable to the economic and political decisions of other countries. Thus, wise use and conservation of mineral deposits, including oil and gas, are vital.

To manage the National Forest System, we need information about the value and location of key resources. Geophysical exploration provides this information.

Geophysical exploration or research is sometimes not well understood by forest officers. Conversely, people engaged in geophysical work are not always aware of national forest management principles, or requirements of the permitting process. This brochure provides information so that all parties have an awareness of geophysical exploration on National Forest System lands.

The Forest Service mission is "caring for the land and serving people." We fulfill this charge with respect to geologic resources and the subsurface environment by adhering to:

SERVICE - Gathering geologic information for determining the nature and location of minerals and other subsurface resources.

TEAMWORK - Understanding the agency's role and that of the geophysical industry and other groups, in order to achieve common goals.

PROFESSIONALISM - Demonstrating sound resource management practices within the concept of ecosystem management and the framework of forest plans.

RESPONSIVENESS - Responding promptly to inquiries and applications for permits to conduct geophysical activities.

Please read on and learn about public land stewardship and geophysical exploration.

JACK WARD THOMAS, Chief
Forest Service
U.S. Department of Agriculture

Introduction—Unlocking the Secrets of the Earth

The techniques described in this brochure represent state-of-the-art technology and are used to learn many things about the National Forest System and the world around us. Geophysicists study earthquakes and increase our ability to predict them. They evaluate the ground stability of sites proposed for large power plants and other kinds of major public projects. They study the surface features of oceans and continents, the configuration and movement of the tectonic plates, the formation of mountain ranges, and changes in the magnetic field of the earth.

Exploration geophysicists gather and analyze seismic, gravitational, magnetic, and other data to learn the shape and properties of subsurface rocks as well as to decide what minerals are in the earth. One important use for these data is to trace the sequence of rock layers and decide on the likelihood of finding oil, hydrocarbons, or geothermal resources in particular locations.

Seismic field crew conducting land survey. Photo provided by Western Atlas.

While this highly complex business, which represents the pre-planning phase in the petroleum exploration effort, often has very limited visibility, it is in fact a major industry in itself. For most people who encounter the geophysical industry, the only component they see is the seismograph field crew working in their area. Thousands of professionals and technicians are employed in the United States as part of the geophysical exploration "team." Worldwide, about $3 billion a year is spent to acquire, process, and interpret geophysical data as part of this process.

Seismic and other geophysical operations have been conducted on National Forest System lands for many years. We have an ever-growing need to conserve the natural resources in our forest ecosystems and use them wisely. To this end, the Forest Service uses geophysical information for energy and mineral resource delineation and management, ground water management, geologic hazard identification and monitoring, and engineering studies for roads and other structures.

At the same time, the oil and gas industry's cost of drilling an exploratory well in its search for domestic energy resources is rising. In this climate, geophysical exploration continues to increase in importance because it substantially improves the success rate of this effort. In addition, the industry is increasing its use of seismic surveys to help maximize production in known petroleum reservoirs.

Looking into the Earth Beneath the Forest

What Do We See?

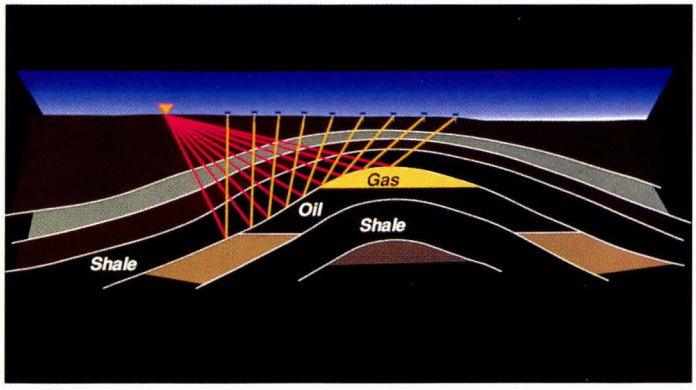
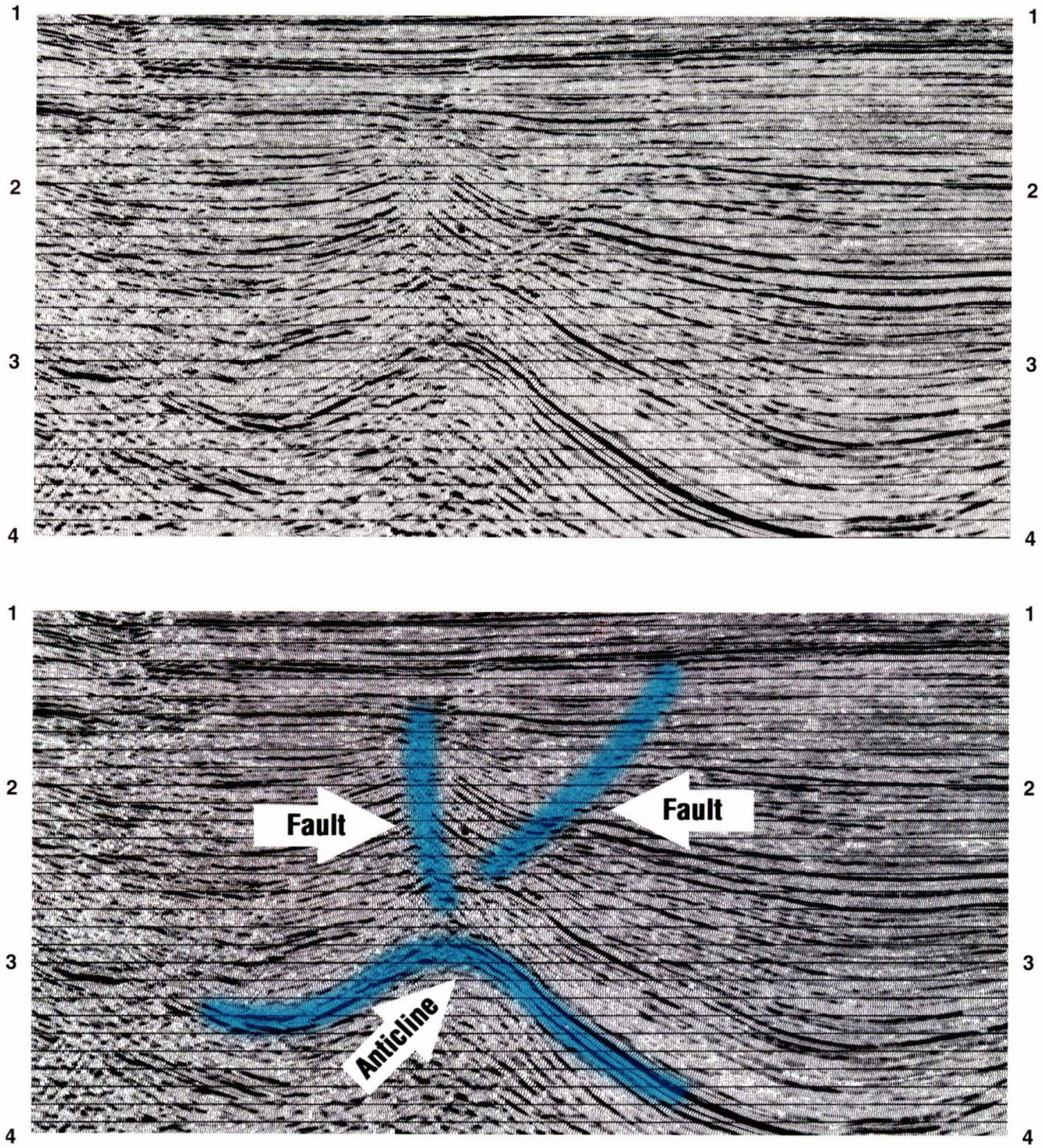


Diagram of earth's surface/subsurface, showing reflected energy and subsurface structure. Photo provided by Western Atlas.



A seismic "section" before and after broad interpretation of subsurface structures. Illustration provided by Western Atlas.

The average person is surprised to learn that there is a highly sophisticated means of seeing the range and shape of rock layers far beneath the forest floor without drilling deep into the earth. The process, known as exploration seismology, is indispensable to our understanding of the geologic processes affecting our lives and to our search for minerals on National Forest System lands.

This remarkable method of seeing the unseen is accomplished through the use of energy waves, called "seismic acoustic waves," which are generated at or near the surface. They penetrate the earth's crust, and reflect back from subsurface rock intervals. Geophysicists record and analyze the reflected signals to produce a seismic "section," which shows the depth of the rock layers. Ideally, such a cross section will reveal a significant pattern where the rock layers are bent, folded, or even fractured. While this subsurface picture won't directly show the presence of mineral resources, it can reveal the structures most likely to contain those resources. Some of these underground areas may contain important commodities such as oil and gas reserves.

Cray or other large computer used in geophysical data processing. Photo provided by Western Atlas.

The rapidly advancing world of computers continues to increase our access to this information. It opens a whole new world that few of us will ever see—the secret world under the national forests. Such a picture or map provides a way for specialists to view structural information in the earth's crust before a well is drilled.

Exploration seismology is part of the larger scientific discipline known as geophysical research. In the early days of seismology, geophysicists generated seismic waves almost exclusively with dynamite; but today, they also use mechanical techniques to produce these energy pulses. Later in this brochure, we will discuss several of the techniques most commonly used in the national forests.

In contrast to the ruggedness of the instruments used to create seismic energy, the receivers (known as "geophones") that are used to "hear" seismic reflections are extremely sensitive instruments—so sensitive, in fact, that they are capable of detecting a person's footsteps on the forest floor many yards away. These geophones are commonly known as "jugs" and are usually placed directly on the ground, laid out in exact patterns, and connected by electronic cables.

Geophones pick up the signal as it bounces off many subterranean rock layers beneath the forest. Each reflection produces its own seismic record on sensitized paper and on magnetic tape. The amount of time it takes for a seismic wave to bounce back from the various rock layers under the forest gives the geophysicist a clue as to the depth of each rock layer. The geophysical industry's ability to record and analyze seismic data has vastly improved with advancements in digital recording instruments. With the development of new computing methods and electronic equipment, seismology remains on the cutting edge of American technology. The largest computers in the world are used to process this vital geological information.

For many years, geophysicists have collected data along linear cross sections of our national forests and grasslands. These surveys provided information beneath the survey line, which was usually displayed as a two-dimensional "slice" of the subsurface. Now, geophysicists distribute geophones over a wider area of the forests' surface, and the information is collected throughout a volume of the subsurface—a method called "three-dimensional" or "3-D" data acquisition. It enables drilling locations to be determined with

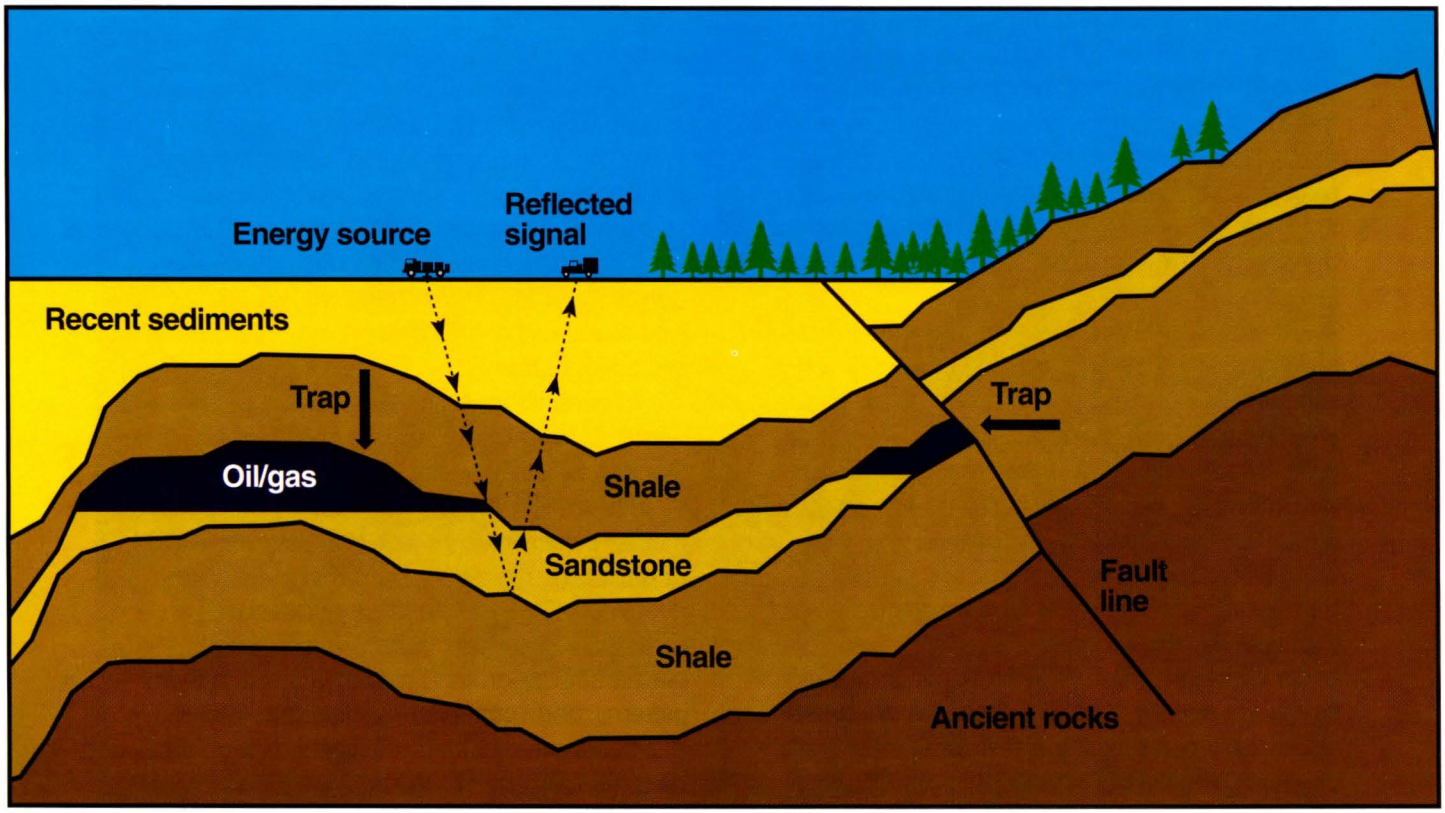


Diagram of the seismic method.

In this case, a vibrator truck (depicted at left) generates energy waves that penetrate the earth far beneath forest vegetation. These waves pass through the various rock layers and are eventually reflected back to the earth's surface. At the surface, the reflected waves are received by the geophones, converted to electrical impulses and transmitted to a second truck (depicted at right). The second truck "records" the electrical impulses on a magnetic tape. After the crews have completed their work, the collected geophysical data are processed and analyzed on computers.

greater accuracy and for many to be eliminated altogether. Geophysicists use 3-D information not only as a geophysical exploration tool but also to better delineate known petroleum reservoirs. Computerized display equipment now makes it possible to compress wide areas of seismic exploration into 3-D pictures that can be viewed on desk-top computers.

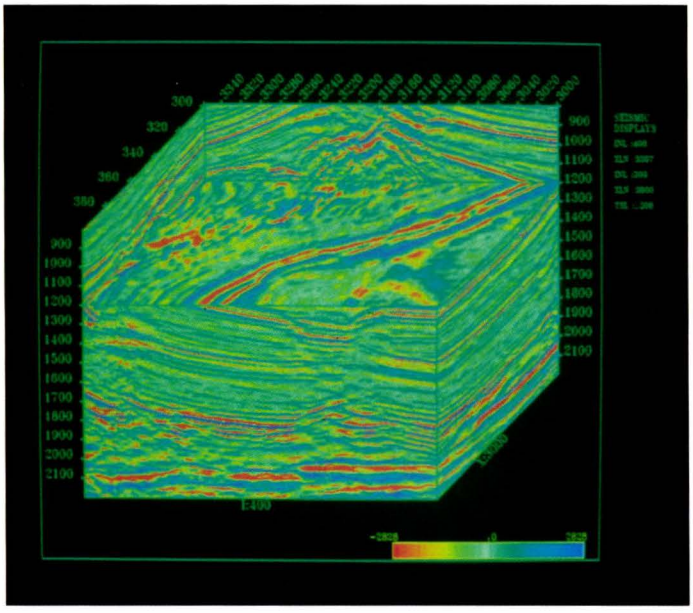
The Stages of a Seismic Operation

Five interrelated stages of field operations are involved in a seismic survey of National Forest System lands. Each depends on the completion of previous operations before proceeding. The stages are:

1. Preplanning and permitting;
2. Surveying the route;
3. Laying out geophones;
4. Generating energy waves and recording data; and
5. Reclamation and cleanup of the site, if needed.

Prior to starting a geophysical program on National Forest System lands, an operator contacts the local Forest Service office to discuss the upcoming survey. After the operational details are worked out and the permit is issued, field operations may begin.

A land survey crew conducts the initial operation in the forest. As they walk through the survey area, they mark the route that the seismic



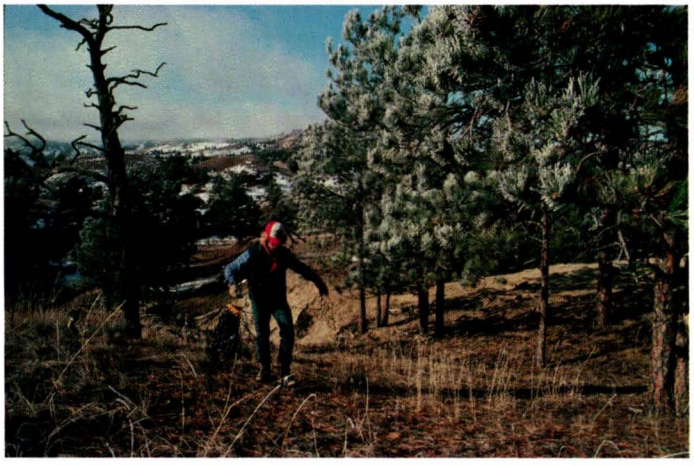
3-D computer generated image. Photo provided by Western Atlas.

line will take. The land survey crew also measures surface elevations along the line and specifies the points where energy waves will be generated and listening devices placed.

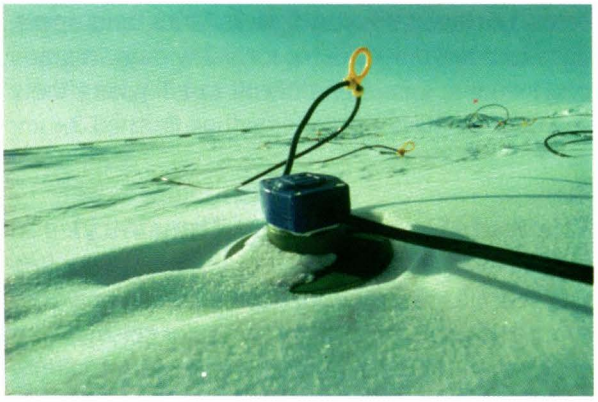
Following the surveyors, an instrument crew lays the sensitive geophones along the seismic line. These are the receiving instruments that will pick up the weak energy waves reflected from the underground rock layers. The geophones will convert the signals into electric impulses, which will be transmitted by cable to the recording truck.

Next, a seismic crew generates energy reflections from beneath the forest floor using one of the tools described below. Methods commonly used on forest lands include "surface shots," small buried energy charges, and vibrators mounted on trucks. The special equipment used and procedures followed for these three methods usually result in little, if any, impact on the surface.

Finally, seismic crews exercise care to reclaim survey sites along the line, if needed. When they are finished, the ecosystem is left as near to its original condition as possible. A permit agent or other representative of the crew coordinates the reclamation and cleanup effort to make sure that the survey area is restored and terms of the per-



Instrument crewman laying out geophones. Photo provided by Western Atlas.



Close-up of a geophone, ready to function in spite of recent snowfall. Photo provided by Western Atlas.

Surface shot pattern visible in vegetation following detonation. FS photo.

Drill cuttings being reclaimed. FS photo.

Poulter method in progress. Photo provided by F.Z. Woodward.

mit have been met. With little surface disturbance of National Forest System lands, and operations that are only present for a few days in any one location, it is often difficult to tell where the survey took place once a crew has finished its work.

The Tools Used (and Why They Vary)

The seismic tools that operators most commonly choose to generate energy waves for seismic exploration on forest lands include: surface shots, traditional shot-hole operations, mini-hole operations, vibrating energy sources, and heliportable operations. Other indirect methods measure gravity, magnetic, and electrical clues to the earth's structure underneath the forest cover. An operator's choice of a particular method may be influenced by prior experience, economics, and environmental concerns. The operator must exercise great care in selecting the method that will ensure collection of the highest quality geophysical data possible.

Surface Detonations

The "Poulter method"—also known as the surface shot—is frequently used in remote areas of the forest and away from populated areas. This is often a portable operation, with helicopters transportating workers and equipment along the survey line. Heliportable operations avoid the use of land-based vehicles, minimize impact on the land, and are usually reserved for the more rugged areas of the National Forest System.

The Poulter method involves mounting small charges on wooden stakes several feet above the ground in a pattern that could include from one to a dozen charges at each shot point. The detonation of these surface charges can be heard for a considerable distance, depending on surface terrain, weather conditions, and other factors. In the areas where it is used, the overall sound level is relatively low.

Traditional Shot-Hole Operations

In this method, the operator drills a hole, places a small explosive charge at the bottom of it, and refills the hole. Detonation of the buried

Shot-hole drilling. FS photo.

charge creates a seismic soundwave. The typical seismic shot hole ranges from 10 to 200 feet in depth and is about 4 inches in diameter.

Operators use larger charges in deeper holes and smaller charges near the surface. In that way, detonations are contained within the hole and the energy generated is forced downward through various rock strata. Usually only a dull thud is heard within the forest environment.

There is a difference between shot-hole operations and the actual drilling of a well, which is subsequently required to search for and produce oil and gas. The bore hole used for a well is usually thousands of feet deep, requires the cementing of steel casing, and often takes several weeks to drill. Shot holes are much shallower, use light equipment for drilling, and multiple holes can be drilled in 1 day.

This operation involves a drilling crew, motorized vehicles, a shot-hole plugging crew, a detonation crew, and reclamation and cleanup personnel. The method chosen to plug seismic shot holes usually depends on local requirements in the area where the operation takes place.

Mini-Hole Seismic Operations

In this type of operation, a drilling crew drills a pattern of 5 to 10 shallow holes, usually 5 to 10 feet deep, instead of a single standard hole. Multiple holes are drilled in the mini-hole pattern to compensate for the smaller charges used closer to the surface. Each charge is normally no heavier than 1/2 pound, and only one detonation cap per charge is usually required.

This method lends itself to use when rock formations on forest lands are so hard that deeper drilling would be uneconomical or inefficient. And, because of the shallower drill holes, fewer personnel and smaller drilling equipment are required. It is also used in areas inaccessible to larger equipment. Its use may be limited when subsurface geology produces inferior data.

Vibrating Energy Source

The vibroseis (pronounced "vibro-size") method involves surface vibration rather than detonations. A specially designed vibrator pad, mounted below a vehicle, is pressed against the ground and vibrated at regular intervals to create energy waves. Crews operate several of these vehicles together to form the energy source. The impression left by the vibrator pad on the ground is minimal.

Vibroseis in the field. Photo provided by Western Atlas.

The vibrator trucks themselves move on tires or tracks. They cause little surface disturbance and are often used in environmentally sensitive ecosystems and along highways. Since they require a fairly flat surface site however, the terrain limits their application.

Heliportable Operations

Helicopters are used as described above to transport equipment into areas not accessible with surface vehicles. Heliportable operations use smaller drilling equipment specifically designed for easy separation into component parts and reassembly on-site.

These operations are frequently similar to traditional shot-hole operations but also include Poulter and mini-hole operations. Heliportable activities are used in those national forest areas inaccessible by vehicles and that require a helicopter to move supplies, equipment, and personnel. Such operations and equipment cannot drill holes as deep as those used in the traditional shot-hole method. Heliportable operations are very expensive and may not produce the quality of data needed.

Heliportable operation. Photo provided by Western Atlas.

Gravity, Magnetic, and Electrical Methods

Several other geophysical techniques are used in exploring for hydrocarbon and other mineral resources. These processes are also used in environmental and archaeological investigations. Geophysicists use instruments to measure the earth's gravitational, magnetic, and electrical properties when rugged terrain makes the seismic survey methods described above infeasible. These alternate methods may also be used to supplement the information obtained from shothole or vibroseis seismic surveys, since the gravity, magnetic, and electrical methods measure different natural phenomena. They often precede a seismic survey.

A gravity meter is usually operated on the surface of the earth, and provides on-site measurement of the gravitational "pull" of the rocks beneath the forest. Denser rocks have a greater gravitational "pull" than do less dense ones. These measurements can indicate the depth of the rocks and the presence of geological formations that may contain economic deposits of minerals or hydrocarbons under National Forest System lands.

Magnetometers, devices that measure magnetic susceptibility of the earth, were originally operated on the ground surface; but today, are commonly carried by aircraft. Processing of the magnetometer's data can lead to the identification of "basement" rocks, overlying sediments, and in some cases the presence of economically productive, mineral-bearing rock layers.

Electrical methods include such techniques as resistivity/induced polarization, electromagnetic and magnetotelluric methods, and spontaneous potential measurements. Electrical surveys measure subsurface rocks' ability to conduct electricity. By processing and interpreting these data, geophysicists try to compare electrical measurements with characteristics of subsurface rock formations. Geophysicists are looking for porosity, permeability, type of fluids in the rock, and lithology. Electrical methods usually have no more impact on the surface of the forest than normal foot traffic, but may require temporary localized surface disturbance at measurement points.

Protecting Proprietary Material

The picture of the subsurface obtained through a seismic survey represents the fruit, or end product, of a research company's investment. The cost of obtaining it is very high. Once the data is collected, the company can sell or trade it to information users, ranging from Government managers to energy companies. In sum, it is an important asset whose market worth fluctuates according to availability, political decisions, and world energy markets.

The Forest Service acts as a trustee or fiduciary agent of this privileged information when it is supplied to the agency. Although research companies are encouraged to publicly release nonproprietary information when it serves the public interest, the Forest Service takes seriously its responsibility as the caretaker of this valuable information while it remains confidential. An unauthorized release of the data would not only be a serious blow to the company that collected it, but also damage the public's confidence in the agency's ability to participate in the public/private partnership. Unauthorized release of the data can lead to substantial penalties.

For some companies, the information contained on the maps accompanying the application letter, which show the layout of the proposed survey, is valuable proprietary information. For others, this may not be so. It is a good idea for the applicant and local Forest Service personnel to

know at the outset which information must be kept confidential.

The Forest Service is occasionally contacted to make information available under the Freedom of Information Act. Although the act specifically exempts the Forest Service from releasing geophysical information, a good rule for Forest Service officials to follow is to not request or accept proprietary information unless such information is definitely needed.

More about the Forest Service

The following information about the National Forest System and its minerals and geology programs is intended to provide a context for permitting and conducting geophysical activities:

The National Forest System Mission—The Forest Service manages the ecosystems of the national forests and grasslands, which make up the National Forest System, to serve the needs of the American people and to conserve them for future generations. The agency is dedicated to multiple-use management of these lands for sustained yields of renewable resources.

Although not renewable, minerals are important resources of the national forests and are vital to the Nation's welfare. By accident of geography and geology, the National Forest System contains much of our country's remaining stores of minerals—prime examples being the national forests in the Rocky Mountains, the Basin and Range Province, the Cascade-Sierra Nevada Ranges, the Alaska Coast Range, and the States of Missouri, Minnesota, and Wisconsin. Lesser known but good mineral potential exists in the southern and eastern national forests.

These same lands, however, also contain valuable nonmineral resources, including wildlife, timber, forage, water, scenic landforms, and wilderness. Public holdings of such nonmineral resources are currently among the most significant in the world.

Under the multiple-use concept, National Forest System lands are managed for many uses. This means, in its most fundamental sense, sharing the land in ways most beneficial in the long term for the most people. The Forest Service gathers, evaluates, and uses geologic and other resource information as an integral part of multiple-use management.

The Minerals and Geology Programs—In part, the Forest Service administers its minerals and geology programs to:

- Provide geologic information needed for the preparation of land and resource management plans, and for interpretation of geologic conditions and processes as they relate to or affect the capability of National Forest System lands to produce resources and support biological diversity of ecosystems.
- Encourage and facilitate the orderly exploration, development, and production of mineral and energy resources on National Forest System lands in order to maintain viable, healthy industries and to promote self-sufficiency in those mineral and energy resources necessary for economic and national security.
- Ensure that exploration, development, and production of mineral and energy resources are conducted in an environmentally sound manner and that these activities are integrated with the planning and management of other national forest resources.
- Ensure that lands disturbed by mineral and energy activities are reclaimed for other productive uses.

Geologic Information Gathering and Mineral Exploration Policy—Forest Service policy with respect to geologic information gathering and mineral exploration is to:

- Process applications, operating plans, permits, and other use authorizations in an efficient and timely manner.
- Plan and provide for access to and occupancy of National Forest System lands consistent with overall management objectives and the rights granted through statutes, leases, licenses, and permits.
- Ensure the uniform application of geologic information gathering, mineral exploration, and reclamation standards.

• Require a reclamation plan for all proposals that would create environmental disturbance.

National Forest System Organization—The National Forest System represents 191 million acres of Federal land, an important part of our Nation's natural resource base. These lands include a wide diversity of geological features and biological systems: mountains, glaciers, forests, range and grasslands, lakes, streams, and both tropical and temperate rain forests. They are administered from 9 regional offices, 121 forest supervisor offices, and 618 ranger district offices. The authority and responsibility that permit the collection of geologic information have been delegated to district rangers, who are also responsible for on-the-ground project administration. Names and addresses of specific national forests can be obtained by writing to the the regional offices listed on page 13, or by accessing directory information at http://www.fs.fed.us on the world wide web.

The Permitting Process in Action

Private Initiative – Application Letter

To ensure that the application process operates as smoothly as possible, an applicant should contact the Forest Service prior to filing. This allows both parties to find out the latest on operating techniques and application requirements. Both parties should review the issues discussed below so that the application can be processed quickly.

When it is time to file an application, an operator notifies the Forest Service several weeks before the proposed survey is to start. The operator sends a letter requesting a Temporary Special-Use Permit, describing the project in sufficient detail for the Forest Service to evaluate the proposed survey. Maps (minimum scale 1:100,000) showing the location of the geophysical activity on public lands, and the desired starting and ending dates, should be included. The narrative description should cover the techniques and equipment to be used, the environmental impacts and mitigations, and the plans for protection and rehabilitation of the area being surveyed. (See appendix A for a sample letter and prototype completed Temporary Special-Use Permit).

Forest Service Response

When the Forest Service receives an application letter, the first step is to initiate internal reviews, including cultural and biological, and to determine consistency of the proposed activity with the forest plan. These reviews utilize existing information to assess known resources and impacts. The Forest Service should not use this process to gain new resource inventories as a prerequisite to permitting geophysical data acquisition.

The nature and location of most geophysical surveys rarely affect resources such as cultural sites and protected species. Consequently, the operator is usually notified of the Forest Service's approval within 10 to 15 working days.

In reviewing the information, the Forest Service identifies the applicable fees and bonds required from the operator. Forest Service managers are also interested in public notification and any off-site impacts. The agency gives special consideration to national forest areas that are wetlands, or that contain cultural resources or threatened and endangered species.

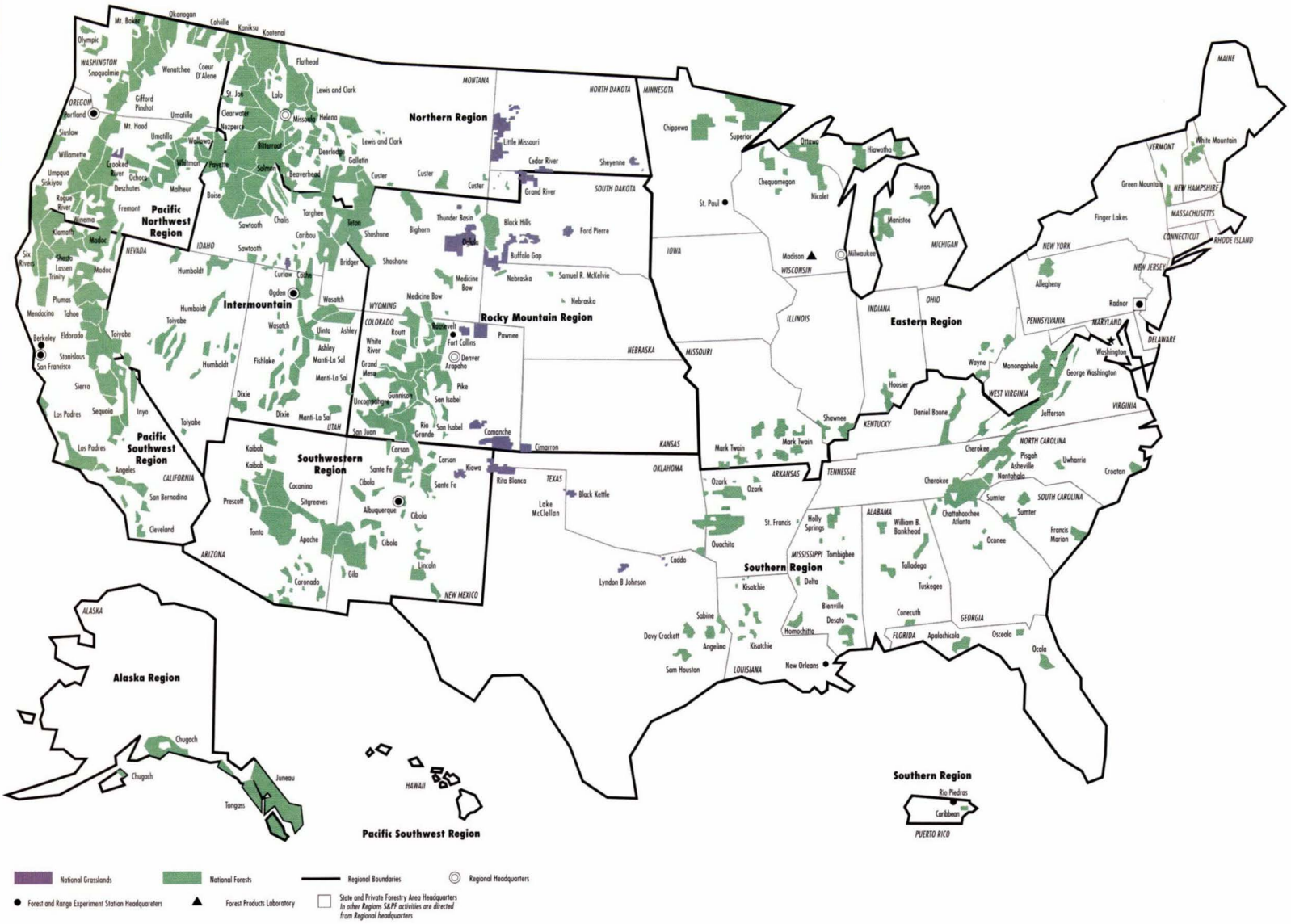
The Forest Service schedules a prework conference or field inspection if necessary to review the conditions for operating in the forest. Agency personnel work closely with the operator to identify any additional information that may be required to process the application letter prior to the prework conference. The Forest Service also contacts other affected agencies and land users upon receipt of the letter. In this way, it coordinates the review of the proposal.

Legal Framework

In addition to the National Forest Management Act, which calls for the Forest Service to review the proposed activity for consistency with the forest plan, the laws that normally come into play in processing geophysical survey applications are:

• The Endangered Species Act (ESA)

The ESA requires an agency to use the "best scientific and commercial data available" in



Please write to any of the addresses below for information:

Regional Forester, USDA Forest Service:

Northern Region
Federal Building
P.O. Box 7669
Missoula, MT 59807

Rocky Mountain Region
740 Simms Street
P.O. Box 25127
Lakewood, CO 80225-2098

Southwestern Region
Federal Building
517 Gold Avenue, SW
Albuquerque, NM 87102

Intermountain Region
Federal Building
324 25th Street
Ogden, UT 84401

Pacific Southwest Region
630 Sansome Street
San Francisco, CA 94111

Pacific Northwest Region
333 SW 1st Avenue
P.O. Box 3623
Portland, OR 97208

Southern Region
1720 Peachtree Road, NW
Atlanta, GA 30367

Eastern Region
310 West Wisconsin Avenue
Milwaukee, WI 53203

Alaska Region
Federal Office Building
P.O. Box 21628
Juneau, AK 99802-1628

making its decisions under the act. The principles of the ESA indicate that projects to gather geologic information should proceed unless it is determined from existing information that the proposed activities are likely to jeopardize the continued existence of a protected species, adversely alter its critical habitat, or result in a "take." In carrying out its decisions, the Forest Service does not require an applicant to conduct new biological studies or inventories.

In using the "best information" approach, two distinct issues are addressed:

1) Does the existing information demonstrate the existence of a protected species or its critical habitat along the proposed survey route?

2) Does existing information demonstrate that the type of survey proposed may adversely impact the protected species identified?

If the answer to either of these questions is "no," the ESA will not be a basis for postponing the survey. This approach eliminates unnecessary and inappropriate delays.

• The National Historic Preservation Act (NHPA)

The Forest Service is responsible for protecting heritage resources on National Forest System lands. Before a permit can be approved, the agency must make a determination of the potential adverse effects of the activity upon important heritage properties. Where existing information is sufficient to determine either that the activity proposed will have no effect, or that there are no important heritage properties in the area of the proposed activity, then no further information is required. When information on the location and significance of heritage properties in the area of the proposed activity is inadequate and the nature of the activity constitutes a potential impact, then additional heritage surveys will be needed.

When important heritage properties are known to exist along the proposed seismic survey route, the Forest Service will notify the applicant of the areas to avoid, or the type of seismic exploration to avoid. See appendix B for appropriate offset distances from heritage properties for certain types of seismic operations.

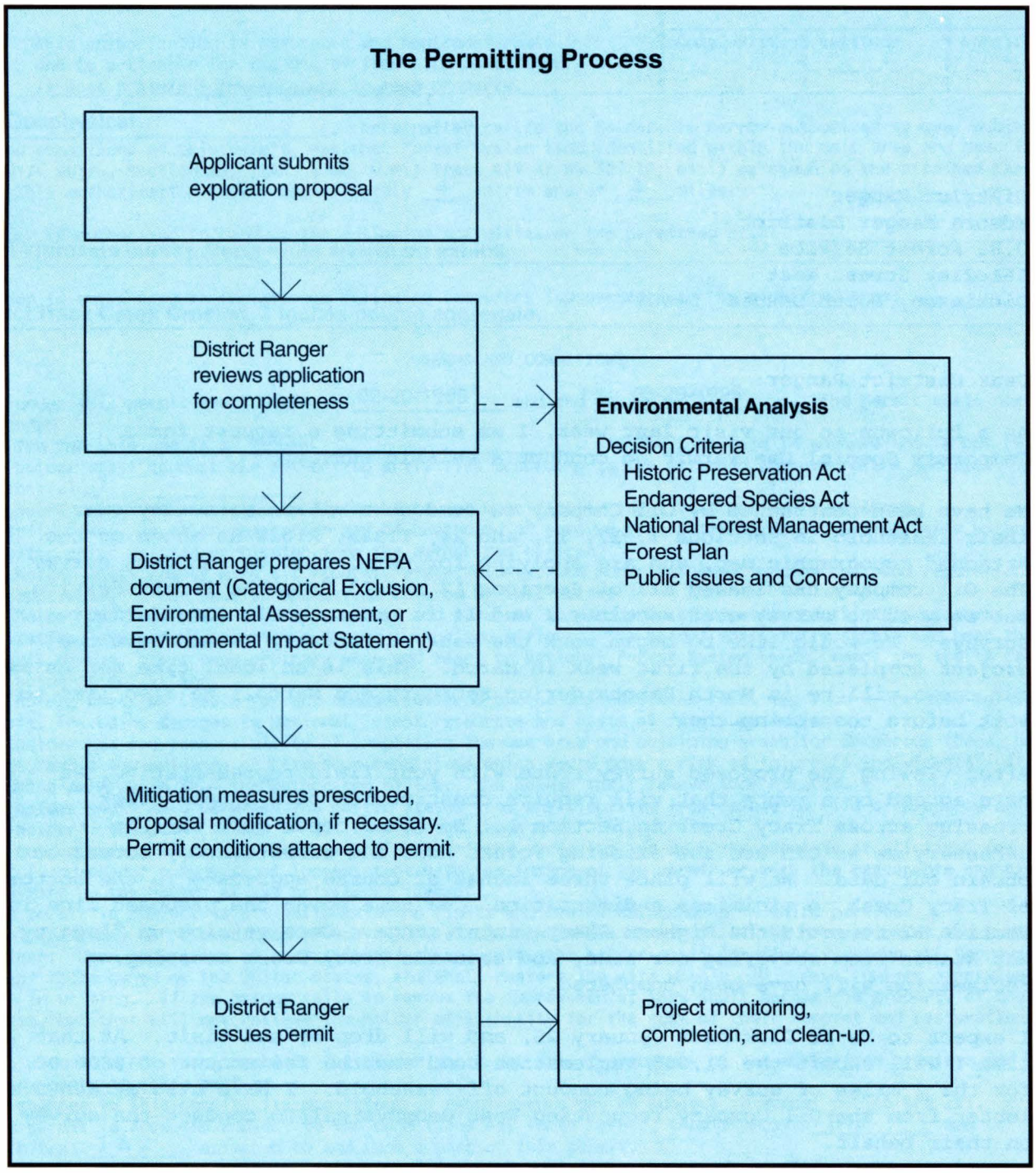
• The National Environmental Policy Act (NEPA)

Central to the Forest Service review is consideration of the environmental implications of the activity under NEPA, using an interdisciplinary approach. It is the environmental analysis and the appropriate documentation under NEPA which serves as the coordinating tool for the ESA, NHPA, and other legal mandates that must be considered in multiple-use management of the national forests.

On land administered by the Forest Service, the Forest Service has the financial responsibility to conduct NEPA analyses where needed, including cultural resource and protected species surveys. The operator has the financial responsibility for protective and/or mitigating measures specified by the Forest Service. In cases where the Forest Service is unable to timely conduct the NEPA analysis, including cultural resource and protected species surveys, the operators may, at their discretion and cost, perform such analyses and surveys through Forest Service-approved contractors or other parties. The Forest Service cannot delegate its financial responsibility to an operator as a condition of permit issuance, or approval of operations.

Once the necessary environmental analysis and internal documentation are complete, the Forest Service will notify the operator to begin. Since a geophysical survey generally has no significant environmental impact, the environmental analysis can usually be completed in a few days. Special terms and conditions may be required as a result of the environmental analysis.

The Forest Service conducts periodic field inspections and performs other monitoring activities during the operation to ensure compliance with the terms and conditions of the permit. When noncompliance items are discovered, the agency verbally notifies the operators and then follows up with written notification by certified mail.


The Permitting Process
Applicant submits exploration proposal
District Ranger reviews application for completeness
Environmental Analysis
Decision Criteria
Historic Preservation Act
Endangered Species Act
National Forest Management Act
Forest Plan
Public Issues and Concerns
District Ranger prepares NEPA document (Categorical Exclusion, Environmental Assessment, or Environmental Impact Statement)
Mitigation measures prescribed, proposal modification, if necessary. Permit conditions attached to permit.
District Ranger issues permit
Project monitoring, completion, and clean-up.

The permitting process is shown schematically above. As mentioned earlier, the process normally takes 10-15 working days. Actual time required will depend on such things as current workload, complexity of the proposal, number of laws relevant to it, and level of public interest.

WEST GEOPHYSICAL 230 N. CASPER, CASPER, WY 82120 307-235-4178

Date: January 2, 1996

District Ranger
Mdeora Ranger District
U.S. Forest Service
161 21st Street West
Dickinson, North Dakota 58601

Dear District Ranger:

As a followup to our visit last week, I am submitting a request for a Temporary Special Use Permit to conduct a seismic survey.

We have been contracted by Oil Company to conduct a vibrosies survey over their leasehold in Sections 1, 12, 13, and 24, T138N, R102W as shown on the attached topographic map, and are applying for permission to run this survey. The Oil company has leased all of Sections 12 and 13 from the Forest Service, but we need to survey over sections 1 and 24 in order to tie into earlier surveys. We would like to begin work the week of February 19 and have the project completed by the first week in March. This is an ideal time for us as our crews will be in North Dakota during February and March. We also like to work before the spring thaw.

After viewing the proposed survey route with your field representative, we have agreed on a route that will require construction of a single creek crossing across Tracy Creek in Section 1. No other dozer work will be necessary as we can use the existing Forest Road and cross-country access to obtain our data. We will place three inches of course aggregate in the bottom of Tracy Creek to minimizes sedimentation. We have moved the proposed line in Section 12 to avoid the Bighorn Sheep winter range. Once we pick up flagging and stakes from surveying our line, and seed the Tracy Creek crossing, reclamation will have been completed.

I expect to be in Dickinson January 25, and will drop by and visit. At that time I will submit the $1,000 reclamation bond and the fee amount of $800.00 for the 2 miles of survey being conduct off-leasehold. I have also attached a letter from the Oil Company requesting West Geophysical to conduct the survey on their behalf.

Respectfully,

Fred Frank

FS-2700-25 (07/93)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
Forest Service

TEMPORARY SPECIAL-USE PERMIT
(FSH 2709.11, sec. 54.6)

Authority: Act of October 21, 1976 (PL 94-579)

This authorization is revocable and nontransferable and is a license for the use of federally-owned land. It does not grant any interest in real property.

Holder No.	Issue Date	Expir. Date
_ _ _ _-_ _	_ _/_ _/_ _	_ _/_ _/_ _
Type Site(s)	**Authority**	**Auth. Type**
_ _ _ _ _ _ _	_ _ _	_ _ _ _
Region/Forest/District		**State/County**
_ _/ _ _ / _ _		_ _/ _ _ _
Cong. Dist.	**Latitude**	**Longitude**
_ _	_ _ _-_ _ _-_ _ _	_ _ _-_ _ _-_ _ _

West Geophysical, hereinafter called the Holder, is hereby authorized to use, subject to the terms and conditions of this permit, National Forest System land identified within the unit area and described as (e.g. NW1/4 NW1/4, Section 26, T24N, R16E, W.M.; Tract 419-A; MS 309 ID; etc.) as shown on the attached Exhibit(s) _____. This authorization covers approximately 4 acres and/or 4 miles.

The holder is authorized to conduct the following activities on the permitted area:
Conduct Vibroseis survey along route shown on exhibit

The holder is authorized to install the following temporary improvements on the permitted area:
Construct Tracy Creek Crosing, 3 inches course aggregate.

TERMS AND CONDITIONS

1. Use under this permit shall begin on 02-20-1996 and end on 03-29-1996. The permit shall not be extended.
2. The fee for this use is $ 800.00. It shall be paid in advance and is not refundable.
3. The holder shall conduct the authorized activities according to the attached approved plans and specifications, Exhibit(s) 1.
4. The holder shall not install any improvements not specifically identified and approved above.
5. No soil, trees, or other vegetation may be destroyed or removed from National Forest System lands without specific prior written permission from the authorized officer.
6. The holder shall comply with all Federal, State, county, and municipal laws, ordinances, and regulations which are applicable to the area or operations covered by this permit.
7. The holder shall maintain the improvements and premises to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the authorized officer. The holder shall fully repair and bear the expense for all damage, other than ordinary wear and tear, to National Forest System lands, roads and trails caused by the holder's activities.
8. The holder shall be liable for any damage suffered by the United States resulting from or related to use of this permit, including damages to National Forest resources and costs of fire suppression.
9. The holder has the responsibility of inspecting the use area and adjoining areas for dangerous trees, hanging limbs, and other evidence of hazardous conditions which would pose a risk of injury to individuals. After securing permission from the authorized officer, the holder shall remove such hazards.
10. The holder shall hold harmless the United States from any liability from damage to life or property arising from the holder's occupancy or use of National Forest lands under this permit.
11. The holder agrees to permit the free and unrestricted access to and upon the premises at all times for all lawful and proper purposes not inconsistent with the intent of the permit or with the reasonable exercise and enjoyment by the holder of the privileges thereof.
12. This permit is subject to all valid existing rights and claims outstanding in third parties.
13. This permit may be revoked upon breach of any of the conditions herein or at the discretion of the authorized officer. Upon expiration or revocation of this permit, the holder shall immediately remove all improvements except those owned by the United States, and shall restore the site within 30 days, unless otherwise agreed upon in writing. If the holder fails to remove the improvements, they shall become the property of the United States, but that will not relieve the holder of liability for the cost of their removal and restoration of the site.
14. This permit is not transferable. The holder shall not sublet occupancy of the authorized premises and improvements to third parties.
15. Any changes to this permit, its provisions or requirements may be subject to appeal per 36 CFR 251.
16. This permit is accepted subject to the conditions set forth herein, condition(s) 1-12 and Exhibit(s) 1 & 2 attached to and made a part of this permit.
17. The above clauses shall control if they conflict with additional clauses or provisions.

HOLDER

By: /s/ West Geophysical
Address: 230 N Casper
Casper, WY 82120
Tel #: 307-235-4178
Date: 1/26/96

U.S. DEPARTMENT OF AGRICULTURE
Forest Service

By: /s/ District Ranger
Name: District Ranger
Title: District Ranger
(Authorized Officer)
Date: 1/26/96

Appendix B
Resource Protection Offsets

The objective of developing the tables below is not to set the conditions for all possible surveys. Rather, it is to establish presumptions for appropriate operating parameters. If the operator proposes to operate closer to a cultural resource or other manufactured facility than the identified distances, the burden should be on the operator to demonstrate the insignificance of effects on the cultural resources that have been identified as existing along the survey route. If the Forest Service or other interested party wants the operator to operate further from an identified cultural resource, the burden should be on the Forest Service or other interested party to demonstrate that the extended distance is necessary to provide adequate protection for the resource in question.

The following figures and tables were derived from studies on effects to commonly investigated contemporary structures (e.g., houses, water wells, pipelines, and springs) and the normal environmental conditions that cultural resources are subjected to on a daily basis (e.g., wind, temperature changes, humidity changes, and vibrations from aircraft, vehicle, and train traffic). It is unnecessary to add additional buffers to the established distances. Distances may need adjustment in saturated soils or extreme weather conditions.

Table I: Recommended Safe Distances from Buried Shots to Cultural Resource Structures and Other Facilities

Uses a scaled distance of 65

Peak particle velocity at these distances will be below 0.75 in/sec under normal conditions

Charge Size (lb)	0.33	0.5	1	3	5	10	15	20	30	40	50	60	75
Depth (ft)													
5	37	46 *	65 *	112 *	145 *	205 *	252 *	291 *	356 *	411 *	460 *	503 *	563 *
10	36	45	64	112 *	145 *	205 *	252 *	291 *	356 *	411 *	460 *	503 *	563 *
15	34	43	63	112	145 *	205 *	251 *	290 *	356 *	411 *	459 *	503 *	563 *
20	32	41	62	111	144	205 *	251 *	290 *	355 *	411 *	459 *	503 *	563 *
25	28	39	60	110	143	204 *	250 *	290 *	355 *	410 *	459 *	503 *	562 *
30	22	35	58	109	142	203 *	250 *	289 *	355 *	410 *	459 *	503 *	562 *
40	-	23	51	105	140	202	249 *	288 *	354 *	409 *	458 *	502 *	561 *
50	-	-	42	101	136	199	247	286 *	352 *	408 *	457 *	501 *	561 *
75	-	-	-	84	124	191	240	281	348	404 *	453 *	498 *	558 *
100	-	-	-	52	105	180	231	273	342	399	449	493	554
125	-	-	-	-	74	163	219	262	333	392	442	488	549
150	-	-	-	-	-	141	202	249	323	383	434	481	543
175	-	-	-	-	-	108	181	232	310	372	425	472	535
200	-	-	-	-	-	47	153	211	295	359	414	462	526
225	-	-	-	-	-	-	113	184	276	344	401	450	516
250	-	-	-	-	-	-	30	148	253	326	386	437	504
275	-	-	-	-	-	-	-	94	226	306	368	422	491
300	-	-	-	-	-	-	-	-	192	281	348	404	476
325	-	-	-	-	-	-	-	-	145	252	325	385	460
350	-	-	-	-	-	-	-	-	65	216	298	362	441
375	-	-	-	-	-	-	-	-	-	168	266	336	420
400	-	-	-	-	-	-	-	-	-	95	226	306	396
450	-	-	-	-	-	-	-	-	-	-	94	226	338
500	-	-	-	-	-	-	-	-	-	-	-	59	259
550	-	-	-	-	-	-	-	-	-	-	-	-	120
600	-	-	-	-	-	-	-	-	-	-	-	-	-
650	-	-	-	-	-	-	-	-	-	-	-	-	-
700	-	-	-	-	-	-	-	-	-	-	-	-	-
750	-	-	-	-	-	-	-	-	-	-	-	-	-
800	-	-	-	-	-	-	-	-	-	-	-	-	-

* Some charge sizes, although safe from a distance standpoint, may be more prudently detonated in deeper boreholes

\- For the depth and charge size listed, no surface location should experience a peak particle velocity over 0.75 in/sec

Table II: Recommended Safe Distances from Surface Shots to Cultural Resource Structures and Other Facilities

Uses a scaled distance of 470

Maximum decibels at these distances will not exceed 140 DB under normal conditions

Charge Size (lb)	0.33	0.5	1	3	5	10	15	20	30	40	50	60	75
Distance (feet)	325	373	470	678	804	1013	1159	1276	1460	1607	1731	1840	1982

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